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Nº VII.

KILN FOR DRYING CORN.

The Large Gold Medal *was this Session presented to Mr.* James Jones, *of Holborn, for a* Vertical Kiln for drying Corn. *The following Communication has been received from him on the Subject, and a Model of the Apparatus is placed in the Society's Repository.*

150, High Holborn,
April 18, 1823.

SIR;

I shall feel much obliged if you avail yourself of the first convenient opportunity of submitting the accompanying drawing and description of a new kiln, for the purpose of drying corn, pulse, &c. to the consideration of the Society of Arts.

I am, Sir,
&c. &c. &c.
James Jones.

Perhaps no subjects which can be brought under the consideration of a society of intelligent men, whose object is the welfare of the community at large, combine so much real interest and importance as those which involve the production and preservation of the chief necessaries of human life; and in this view I believe the great value of a speedy and effectual method of drying grain is too evident to require impressing on the minds of those, particularly, who are in the least acquainted with the business of the farmer, the corn-factor, or the miller. The frequent occurrence of crops being, on account of unfavourable weather, necessarily carried from the field in a state of considerable humidity, every one must be aware of; and the consequent reduction in the value of the produce, arising from the deterioration in its quality, cannot be less evident. The heat generated by the fermentation in the heap, together with the moisture, causes germination to take place in the grains near the surface, whereby the farina is decomposed, and the nutritive properties are in a great measure destroyed, whilst the lower part becomes mouldy and acquires a musty smell, of the most foul and disgusting kind; but grain laid up in a perfectly dry state suffers no change, and history furnishes numerous instances of the discovery of ancient granaries, wherein the corn has been preserved in the most perfect condition for a long series of years; which, if it had been stored in a state of dampness, would have inevitably been destroyed. This, in the time of wet harvests, renders essentially necessary some artificial means of speedily dissipating the moisture, which is so destructive if allowed to continue in the grain, and the only means of effecting this object is by the use of the common kilns; but which, in very bad seasons, on account of the slowness of their operation, are not sufficiently numerous to answer the purpose to the extent required, and the government find it requisite to permit the drying of grain on the malt-kilns. As an appendage to large granaries, or corn-stores, kilns are of infinite utility, both as affording the certain means of preserving the grain from any tendency to fermentation whilst lying in store, and fitting it for water-carriage by that degree of dryness which is absolutely necessary to prevent its heating on board, where the opportunities of turning it are so limited, if not altogether wanting, although the necessity of it is increased; and to the miller the use of a kiln is not less important, as without a certain degree of dryness the wheat will not grind freely, it clogs the stones, and good flour is not produced; and I believe it is a very general practice with millers who possess the means, to pass all wheat over the kiln when the flour is intended for water-carriage; at least I know it is the custom at some mills, and indeed it is perfectly well known that new flour, particularly of the finest quality, when in a damp state, has a remarkable pre-disposition to encourage the propagation of those minute insects which are so totally destructive of its good properties.

The common kiln is so well known that little need be said in the way of description, except to enable those who are unacquainted with its construction to judge of the comparative merits of the old kiln and the one hereafter described: suffice it to say, that it consists of a floor usually composed of Bridgewater tiles, which are large square flat tiles perforated with a great number of small holes; or otherways, of iron plates perforated in the same way; or of wove wire-work, either kind being supported on iron bearing-bars extending from wall to wall. Beneath this floor, or kiln head, as it is frequently called, are built four portions of arches of brick work, which together compose a form somewhat similar to an inverted frustum of a pyramid, whose larger base is equal to the area of the floor; and in the lesser base, which is supported on low walls, is placed, at the distance of five or six feet from the tiles, a fire, composed of coke, culm, or other suitable fuel, the heated air and vapour from which ascends into the pyramidal space above it, spreading rather unequally over the inferior surface of the floor, passing through the perforations made in it, and through the interstices between the grain, which is spread in considerable thickness upon it; the lower part of the stratum thus necessarily gets considerably heated, and the humidity is evaporated. After a lapse of time, dependent on the state of the grain, it is turned over with a large wooden shovel, or scoop, for the purpose of removing those grains which were before at the top, nearer to the heated surface, and those which are sufficiently dried to the top, and is then suffered to remain until it is fit to be turned again, if from its previous damp state that is necessary, or to be removed entirely from the kiln, when a fresh quantity is submitted to the same operation. The length of time it lies on the kiln depends on the proportion of moisture contained in the grain, and varies from five to eight or nine hours, indeed Mr. Tull states the occasional necessity of it to extend as far as twelve hours. On the kilns used previously to the one I erected, the average time required for the purpose was seven hours and a half, during which time four quarters and a half were dried, being at the rate of fourteen quarters and a half per day.

The imperfections of this method are so glaring, that it must excite surprise that no effectual means have been devised to obviate them: for I believe the only alterations either effected or proposed, have been in the manner of heating, whereby the grain might imbibe less of the unpleasant flavour derived from the fuel; with only one exception that I am acquainted with, which is at a mill in Wapping, where the wheat is constantly turned over by the action of a traversing and revolving rake, similar, I believe, to that for which Mr. Barchard was rewarded by the Society.

It must be evident that a stratum of wheat several inches thick, cannot be equally heated through all its parts in a short time, and, consequently, that the moisture which is expelled from the grains nearest the tiles, by the first effect of the fire, in the form of steam, must, in its ascent, be condensed and deposited on the colder grains which are nearer to or at the surface; and, consequently, so far as regards the upper part of the stratum, the evil is doubled, and until the grain is turned over (unless that operation is excessively delayed), the upper portion does not part with any of its previous or acquired moisture, and when it is turned, it must be allowed to remain long enough to evaporate perhaps twice its original quantity of humidity, during which time the part which was first dried re-absorbs much of the moisture exhaled from the other grains, by which the time requisite to expel the whole is greatly extended; and in this view I am confirmed by the very short time which proves sufficient in the mode I have adopted. Whether any, or what chemical action takes place, detrimental to the flour in this protracted state of humid heat, I am not prepared to state, but I think it will not be doubted that the least possible time in which the purpose can be effected, the less chance there is of injurious change; and I also think it will be admitted that in those kilns which are heated by the direct action of the fire, the longer the grain remains, the more it will imbibe of the unpleasant effluvium arising from the fuel; but in kilns where the drying is performed by heated air alone, this objection does not exist. The operation of turning must obviously be an imperfect and inefficient one, notwithstanding every attention may be paid by the man performing it, for it is impossible he can turn the whole completely; but, from the circumstance of its being an unpleasant operation, it is seldom performed as effectually as it perhaps might be; but let the care and attention employed be unlimited, still, from the inequalities of the surface on which the grain lies, it is utterly impossible that the turning can be so complete but that some of the grains remain undisturbed, and much is necessarily again brought into contact with the tiles, and therefore becomes over-dried, to the injury of the entire quantity; and, in fact, the experience of every day shows the inequality of this mode of drying, as frequently, if not always, some of the grains are quite parched, whereby the quality of the flour is much injured, while others are thrown off the kiln almost as damp as when laid on.

That the imperfections here stated attach to the use of the common kiln, every person acquainted with the subject will, I believe, acknowledge, and to such persons the communication of an effectual remedy will not be unacceptable.

In the latter part of the year 1821 I was applied to by John Snook, esq. the proprietor of large mills at Bedhampton, Hants, to endeavour to effect some improvement in his kilns, so as, if possible, to obviate the existing objections, and although I acknowledge that at that time I was perfectly unacquainted with the subject, very little reflection sufficed to convince me that the principles of the old method were bad; and I, therefore, instead of attempting any alteration in the old kilns, after a good deal of consideration, proposed the adoption of one altogether new, both in construction and the manner of its operation, which I hoped would possess in an eminent degree those properties which are essential to a perfect mode of drying, and which requisites I conceive to be, the exposure of a very thin stratum of grain, an equal temperature, the passage of a very large quantity of warm air, and an uninterrupted removal or turning; each of which are indispensable where perfection is sought. This proposition was approved, and in June last year it was set to work, and the first trial sufficiently proved the superiority of the new method over the old one, for the work it did compared with one of the old kilns, which was at work a few days before, and with the same wheat, was rather more than as six to one. This, indeed, far exceeded the effect my most sanguine anticipations had suggested, and amply confirmed my previous opinion of the old kilns. Thus sanctioned by the test of experience, I submit it to the consideration of the Society of Arts, feeling conscious that the importance of the subject will be thought sufficient apology for this communication, particularly as it has some analogy to the ultimate object of the premium, No. 34, " For harvesting Corn in Wet Weather."

The drawings explanatory of the machine are,

Plate XIII, fig. 1, an elevation.

Fig. 2, a vertical section through the line *a b*.

Fig. 3, a horizontal section through the line *c d*, and

Fig. 4, a vertical section of the fire-place, on the line *e f*. The same letters indicate the same parts in each figure. The body of the kiln is composed of two concentric cylinders A A and B B, closed at top and at bottom by two concentric cones C C and D D; the external cylinder, and the bases of its two cones, are 6 feet 2½ inches diameter, and 8 feet high; the internal cylinder and its two cones are 6 feet diameter and 7 feet 10 inches high; leaving an annular space, one inch and a quarter wide, between the internal and external bodies, which are perforated iron plates, having 2,300 small holes in each square foot. The kiln is supported on five cast-iron columns E E E E E, 6 feet 6 inches high, which are attached at their tops to a strong iron ring which surrounds the base of the cylinder. From the heads of these columns descend along the sides of the cone five long bolts G G G G G, which are passed through the same number of lugs in the cast-iron ring H, which surrounds the neck of the lower cone; from the same ring H also proceed five stays I I I I I, which are fastened through the middle of the columns, by a nut on each side. The columns were made of the height here stated for the purpose of enabling the wheat to be received into sacks, that being the most convenient under the particular circumstances; but in a mill where an elevator is near at hand, or where it would not be inconvenient to allow the wheat to run on the floor, the whole kiln might be brought lower down, and I would always recommend as great a length of cylinder as the height of the granary floor will admit of, as by the grain having a greater distance to descend, the motion would be more rapid, and, consequently, the turning will be more complete. The body is sustained both internally and externally by iron hoops K K K, and the distance between the cylinders is preserved by a number of short stays. When the kiln is in operation the annular space before spoken of is entirely filled with wheat, by means of the spout W, from the granary, which keeps up a constant supply as fast as its exit is allowed at the discharging spout X, the opening of which is governed by a regulator, being adjusted to the time requisite to evaporate the moisture.

In the front of the kiln is cut out a space L M N O P, in which is fixed the fire-place L M O P, in which Q is the fire hole, and R R are openings with doors, for the purpose of cleaning the flues; S is the ash-hole and T the fire bars. On reference to the sections, it will be seen that there are vertical air-passages round which the flame and heat of the fuel circulates to the right and left, until it reaches the chimney, which rises through nearly the centre of the kiln; the course of the flame is evident, by the direction of the arrows, and in its passage to the chimney it very powerfully heats the plates which form the sides of the air-passages, and occasions a constant rush of hot air through them into the body of the kiln. The whole of the fire-place being enclosed within the kiln, it is entirely surrounded (excepting in the front) by a thin shell or casing of grain, and from its perfectly insulated situation, no part of its heat can escape, without having first performed its destined office. The triangular space or opening immediately over the fire-place answers two purposes, the chief of which is, diverting the wheat as it descends, from coming too near the fire, whereby it would be parched; and it affords a convenient entrance into the kiln when requisite. It was at first intended to use a plain open fire-place, with coke or culm, when a chimney would have been unnecessary, and all the heat would be available, which with a chimney is not possible, as of course some heat escapes that way; but it was thought desirable to have a close fire-place which would produce the required effect with any ordinary fuel, merely by the radiant heat of the iron plates and a current of hot air, without subjecting the wheat to the effluvia arising from the fuel; and I accordingly made it in the way here shown. The front part of the fire-place is supported on the heads of the two front columns, and the hinder part within the kiln by the pillar *g*, the top of which is fixed in a socket in a bearing-bar across the bottom of the fire-place, and the lower end stands in a cup in the intersection of an iron cross, which rests in the ring H, before-mentioned, and the weight of the fire-place (nearly 15 cwt.) is consequently sustained by the bolts G G which descend from the heads of all the columns. This weight might perhaps have been reduced, but I would rather make it heavier than lighter; feeling satisfied that the drying must be the more regular, the greater the weight of metal in the fire-place; as from any inattention in the care of the fire, the temperature of the whole mass would be less suddenly affected, either by excess or defect of firing.*

From this description, together with the drawing, the construction will be easily understood; and few words will be requisite to explain its operation. The fire having been lighted, the wheat is admitted from the granary, the regulator at bottom being for a few minutes kept shut; when the annular space being full, the only way the warm air contained in the upper part of the kiln can escape, is through the holes in the iron and the interstices between the grains; and as the stratum or shell of wheat is so thin, the passage of air is very rapid, and consequently the moisture is taken up by it, and carried off with the utmost celerity. With regard to the motion or stirring it undergoes, a few words may be requisite. It is obvious that the apex of the cone (where the wheat enters) must have the greatest heat; here it is in a state of constant diverging motion, rapid where the heat is greatest, and progressively slower as the temperature diminishes, until it reaches the cylinders, where the motion becomes equable; here the wheat would perhaps descend bodily (particularly if the kiln was made of wove-wire, as at first intended), but the roughness left by the punching of the holes in the iron-plate, is highly useful, as the little resistance it offers to the grain sliding down, produces a constant, slow, rolling, intestine motion, whereby every individual grain is exposed to the same degree of temperature; it then again converges in the lower cone, producing the same turning and mixing motion, as in the upper cone, and ultimately escapes through the spout at the bottom, either into sacks, or on the ground as may be desired. It will be perceived that evaporation is at first strongly excited by as considerable a degree of heat as the purpose will safely admit of, which evaporation is then gently kept up by a progressively decreasing temperature, as the grain descends towards the discharging spout; and it will be obvious that the grain need not be subjected to the same degree of heat during the whole time it is in the kiln, if we reflect that in each individual grain, the surface is very speedily dried by the elevated temperature of the air it is at first exposed to; and then the superficial particles abstract the moisture from the internal ones with considerable avidity; the external ones being already sufficiently warmed give out this acquired moisture in the form of vapour, which is eagerly taken up by the passing current of warm air, the miscibility of which with water is increased by its increased temperature; and I am certain that a greater degree of heat may safely be applied while the grain is constantly turned, than could possibly be allowed, if it lay at rest, whereby the part immediately exposed would inevitably be overdried. It may also be mentioned that during the time the kiln is at work, the operation of screening is to a certain extent constantly going on, by which, much of the dust, seed, insects, and other extraneous matters are separated; and it is well known that grain cannot be too well screened from all impurities, previous to storing, as its perfect preservation depends much on that circumstance. The rapidity of its operation is such, that when it was tried on two different days before I left it, the grain flowed from it perfectly dried, four bushels and a half, in five minutes and a half, being at the rate of 29 load, or 145 quarters per day; which can only be accounted for by the circumstance of the aqueous vapour being carried clear away at once, without any part of it being deposited on other grains, and from the great quantity and rapidity of the current of warm air which constantly passes between the grains, taking up the humidity as quick as it is converted into vapour; for the temperature within the kiln, as far as I could reach to hold the thermometer, did not exceed 94°; and, indeed, I scarcely know how I can show the imperfections and inferiority of the ordinary system plainer, than by saying that the grain (under an average state) does not require to remain in the new kiln longer than half an hour; while the same wheat will not be dried on the old kiln in less than seven hours and a half. Thus the advantages when compared with the common mill-kiln will be seen to be these—the horizontal space it occupies is not more than one-thirtieth of that which would be occupied by the ordinary kilns capable of performing the same quantity of work; it saves all the labour of the scoop, required in charging, turning, and discharging the common kiln; the wheat is kept in a constantly uninterrupted state of turning, infinitely superior to that by the agency of the scoop, as not even a single grain can remain at rest; the comparative consumption of fuel is much lessened, being about half a bushel per load, and common coal is more suitable for the purpose than culm, which gives less flame, and is more expensive; it is dried with perfect equality, and above all, the quantity it will dry is six or seven times as great as by the common method; for the kiln which was removed to make room for the new one, dried (as before stated), on the average, fourteen quarters and a half per day, and it will be seen by the accompanying certificate, that the medium quantity is 95 quarters; then, as 95 : 14·5 : : 6·5 : 1. Or if we take the quantities before-mentioned, the proportion will be as 10 to 1. For, as 145 : 14·5 : : 10 : 1. This to the corn merchant is an advantage of much importance; as frequently, on sudden changes of the markets, it is desirable to ship the grain with the utmost despatch, but the shipment is often much delayed by the necessity of kiln-drying the cargo previous to loading the vessels; by which delay, arising from the tardiness of the common operation, the advantages of a good market are not unfrequently lost.

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* The height of the fire from the ground, renders necessary some convenient means of reaching it, for which purpose a platform is raised about 4 feet 6 inches, supported on brackets which are bolted on to the two front columns; and on this platform the man stands to attend the fire; which, if (as I have elsewhere observed) the whole kiln is brought lower down, would be unnecessary.

I have in the outset noticed the occasional necessity that farmers are under, of drying their crops of corn, peas, beans, &c., and for the use of the farmer only, this kiln may be made of less size, unless in very large establishments, but it is on a large scale that the advantages will be best shown; neither does the expense increase directly as the dimensions. The application of the principle here used, to the purposes of malting, is easy and evident; but considerable modification in the detail would be requisite, as the germination of the radicle would prevent that kind of semi-fluidity of motion which simple granular substances are susceptible of.

Thus having stated all that appears to me requisite to render the thing clearly understood, I beg to repeat that my perfect conviction of its usefulness and importance in the preservation and preparation of one of the most valuable and indispensable articles of human sustenance, is my inducement to submit it to the Society's consideration, and if any further information is required, I shall feel happy to give it in person.

JAMES JONES.

CERTIFICATE.

Bedhampton, near Havant, Hants,
April 30th, 1823.

This is to certify, that Mr. J. Jones, of High Holborn, did, in July 1822, erect for me a kiln for drying wheat, on an entirely new construction; that it occupies very little space; it saves the labour of the scoop in charging, turning, and discharging, as in the common kiln; the grain is kept constantly in slow motion, whereby the drying is more equal, and it will dry from 60 to 130 quarters in 24 hours.

John Snook.

A farther Certificate, to the same effect as the preceding, has been received from E. F. Hawes, Esq., of Crowborough Lodge, East Grinstead, for whom Mr. Jones has constructed a kiln.

ERRATA.

Page 134, *line* 4, *for* "rested," *read* rolled.
—— — — 14, *for* "acting," *read* action.
——136, — 18, *for* "opposition," *read* apposition.
——137, — 1, *for* "rested," *read* rolled.
——140, — 10, *for* "observation," *read* observations.
——141, — 30, *for* "these," *read* their.
——144, — 13, *for* "opposition," *read* apposition.
——155, — 6, *cancel* "and the brass plate B."

——178, — 3 *from bottom, for* "Hawes," *read* Howes.
——230 *(note) last line, for* "§ 28," *read* § 29.
——298, *before* "Henry Goodwyn," *insert,*
T. Gill.
Technical Repository for 1823, 8vo.